# There is no ´A´ in CD&E, neither for Analysis nor for Anarchy - Ensuring Scientific Rigour and Analytical Structure while maintaining Military Relevance and Artistic Freedom

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## *ABSTRACT*

*As a consequence of the ending of the Cold War, the defence forces of many countries in the world are going through radical transformation and reformation. For many countries, Concept Development and Experimentation (CD&E) has become the main vehicle for developing and testing new ideas during this transformation. The Swedish Armed Forces (AF) has also adopted CD&E as its main instrument in its endeavour to reform its forces. In order to ensure that the methodology was properly known throughout the Swedish AF in general, and among the officers directly involved in CD&E in particular, it was decided by the Swedish AF Head Quarters (HQ) that a CD&E Handbook should be produced. The author of this paper was one of the members of a small working group that was assigned the task of producing such a handbook. In the extensive literature study that was the initial step in this work, it was established that most of that which had hitherto been written about CD&E was either describing different classifications and categorisations of different types of concepts that could be developed, or was focusing on the different types of experiments which should ensue to test the concepts that were being developed. In comparison, relatively little was written about other analytical methods that could be used in order to ensure that, at all times, "the right concept" was being developed and that it was being developed in "the right way", i.e. to make sure that the maturing concept was tested throughout its development in order to assure quality, ensure transparency and in order to provide an audit trail. The purpose of this paper is to present a case for why a structured analytical support is needed in order to ensure that, at all times, "the right concept" is being developed and that it is being developed in "the right way", i.e. to promote an analytical approach to avoid "anarchy" in CD&E by the introduction of analytical support as quality assurance. For managers of CD&E, it is necessary to be able to state that scarce resources are being used to develop the right concept. For managers, concept developers and experimenters, it is necessary to be able to state that the scarce recourses are being used to develop and test the concept in the right way. For the analyst, it is necessary to provide managers, concept developers, and experimenters with the appropriate analytical support to make sure that the right concept is developed in the right way, but also in order to assure quality, ensure transparency and to provide an audit trail. For the scientist, it is necessary to provide the CD&E community with adequate input, bearing in mind that experiments are being conducted on social systems, i.e. systems which to a large extent involve human beings and their behaviour, not natural systems, i.e. systems which are being governed by the laws of nature.*

## 1.0 INTRODUCTION

Two decades ago, the Berlin Wall came down, East and West Germany were reunited, the Soviet Union (SU) was dissolved, and the Warsaw Pact (WP) broke up, effectively putting an end to the era of the Cold War. In the United States (US), the ending of the Cold War and the ensuing changes in defence and security policies, in combination with the revolutionary development in the area of Information and Communication Technology (ICT) and Lessons Learned (LL) from the First Gulf War, eventually led to

# Report Documentation Page

*Form Approved*
*OMB No. 0704-0188*



| 1. REPORT DATE | 2. REPORT TYPE | 3. DATES COVERED |
|---|---|---|
| **APR 2010** | **N/A** | **-** |

| 4. TITLE AND SUBTITLE | 5a. CONTRACT NUMBER |
|---|---|
| **There is no ´A´ in CD&E, neither for Analysis nor for Anarchy - Ensuring Scientific Rigour and Analytical Structure while maintaining Military Relevance and Artistic Freedom** | 5b. GRANT NUMBER |
| | 5c. PROGRAM ELEMENT NUMBER |
| 6. AUTHOR(S) | 5d. PROJECT NUMBER |
| | 5e. TASK NUMBER |
| | 5f. WORK UNIT NUMBER |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **FOI, The Swedish Defence Research Agency SE-164 90 Stockholm Sweden** | 8. PERFORMING ORGANIZATION REPORT NUMBER |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) | 10. SPONSOR/MONITOR'S ACRONYM(S) |
| | 11. SPONSOR/MONITOR'S REPORT NUMBER(S) |

12. DISTRIBUTION/AVAILABILITY STATEMENT
**Approved for public release, distribution unlimited**

13. SUPPLEMENTARY NOTES
**See also ADA564688. Analytical Support to Defence Transformation (Le soutien analytique a la transformation de la Defense). RTO-MP-SAS-081**

14. ABSTRACT

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15. SUBJECT TERMS

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT | b. ABSTRACT | c. THIS PAGE | | | |
| **unclassified** | **unclassified** | **unclassified** | **SAR** | **18** | |

**Standard Form 298 (Rev. 8-98)**
Prescribed by ANSI Std Z39-18

an unprecedented military transformation, labelled a Revolution in Military Affairs (RMA). Initially, the RMA was based on concepts such as Dominant Battle-space Awareness (DBA) and Precision Engagement (PE). Later, new concepts, like Network Centric Warfare (NCW), would contribute to the transformation.

In Sweden, both the military and the politicians were inspired by the development in the US, and about a decade ago, the Swedish Government decided that the Swedish defence should be transformed from a Cold War national defence, designed to defend Sweden, to a Post Cold War operational defence, designed to be flexible and deployable throughout the entire globe. As a consequence of this decision, the Swedish Government assigned the Swedish AF with the formidable task of developing a concept for a future deployable defence, based on a network concept, initially labelled a concept for a Network-Based Defence (NBD). Later, the network based aspect of the new defence would become subdued in favour of new concepts such as Effects Based Operations (EBO); the Effects Based Approach to Operations (EBAO); the Comprehensive Approach (CA); and, most recently, expeditionary operations.

The ensuing development within the Swedish AF was divided into four distinct Command and Control (C2) system development projects in the areas of Methodology (M), Technology (T), Personnel (P), and Organisation (O), labelled C2-system M, C2-system T, C2-system P, and C2-system O, respectively. The development project C2-system T was assigned to the Swedish Defence Materiel Administration (FMV), i.e. the Swedish Defence Procurement Agency (DPA), and got underway more or less immediately. The development project C2-system M, and later also C2-system P, was assigned to the Swedish Joint Forces Command (JFC). After a slow start, these two projects eventually got momentum once the Joint Concept Development and Experimentation Centre (JCD&EC) was established as the Swedish experimental platform. The fourth development project, C2-system O, was never initiated, since it was decided that the organisational issues would be dealt with once the other parts of the new C2-system were in place.

The development project C2-system T, which got a head start, decided to use the IBM Rational Unified Process (RUP), which is an iterative software development process framework, as its preferred method of development. Once the development project C2-system M started its development, it was decided that this development project should have the same development method as the development project C2-system T, i.e. RUP. After some adaptation, RUP-SE (Systems Engineering) was adopted as the preferred development method by the project. Over time, however, many other development methods were utilised, and evolutionary development was a principle that was established early on in the development. About four years ago, when the project was approaching its deadline, i.e. 2006-12-31, a reasonably stable Modus Operandi (M.O.) had been established within the development project C2-system M. This method consisted of what can only, in retrospect, be described as concept development followed by tests in the form of experiments. It was soon realised that this M.O. had a striking resemblance to what was known about a method that was becoming increasingly popular in the international transformational community, i.e. CD&E. What was known in Sweden about the CD&E method was, however, precious little, and, for some reason, it proved difficult to identify a thorough description of the method anywhere among the countries that were, allegedly, developing concepts in accordance with the new method. It was, however, surmised that the two development methods had more similarities than differences.

Four years ago, the three development projects C2-system M, C2-system T, and C2-system P were terminated [1] in accordance with the original plan. However, the JCD&EC lived on, and the development activities were continued within the traditional military organisation. When the development projects were terminated, it was decided by the Swedish AF HQ [2] that all concept development within the Swedish AF should be pursued in accordance with the development method that had been utilised by the development project C2-system M, i.e. a method that had never been described in any detail, but which was considered to be identical with, or at least very akin to, the international CD&E method. At the JCD&EC, the implications of the decision by the HQ were immediately realised. Within the Swedish AF, development centres and development units within numerous schools would soon look to the JCD&EC for guidance regarding the utilisation of the CD&E method. The Swedish National Defence College (SNDC), which

very swiftly initiated academic CD&E courses, would certainly soon look to the JCD&EC for support. Within the JCD&EC it was also realised that if "*all concept development within the Swedish AF*" should follow the CD&E method, this would have to be done at development centres and development units within schools without the support of independent analysts and scientists. In fact, it would have to be done without the direct support of the JCD&EC. It was promptly decided by the JCD&EC to produce "The Swedish Armed Forces CD&E Handbook". It was also decided that the handbook should not only include descriptions of concepts, concept development and experiments, but also descriptions of the other analytical tools that could be utilised during the concept development. In addition, the handbook should also include the managerial perspective, e.g. the decision making process.

The author of this paper was one of the members of a very small working group that was assigned the task of producing such a handbook. In the extensive literature study that was an initial step in this work, it was established that most of that which had hitherto been written about CD&E could be categorised as providing contributions by: describing different definitions, classifications and hierarchies of military concepts [3, 4, 5, 6, 7, 8]; generally describing concept development [3, 4, 8, 9, 10]; addressing different types of experiments [4, 5, 10]; or focusing on how these experiments should be planned, executed and evaluated [10, 11, 12, 13, 14, 15, 16, 17]. Regarding different forms of analytical tools at disposal, some contributions could be identified, but none of these were detailed [3, 4, 5, 9, 10]. On an overall level, there were descriptions of the entire CD&E process [3, 4, 5, 9, 10]. From the managerial perspective, only one contribution could be identified [5]. On a more detailed level regarding the analytical methods that could be used in order to ensure that, at all times, "the right concept" was being developed and that it was being developed in "the right way", i.e. to make sure that the maturing concept was validated throughout its development, in order to assure quality, ensure transparency and in order to provide an audit trail, precious little was found [4]. However, ambitious initiatives like the Integrated Analysis and Experimentation Campaign (IAEC) [9, 10] were referred to and comprehensively described, but would seem to presuppose the participation of an external, objective organisation, with the necessary competence to plan and execute the Integrated Analysis and Experimentation (IAE) activities.

In this paper, some of the theoretical findings of the literature study are presented in Chapter 2.0. In Chapter 3.0, five different perspectives on CD&E, primarily empirically based on the author's experience of CD&E in practise, are presented. In Chapter 4.0, these different perspectives are used in order to discuss why a analytical structure is required in CD&E. The conclusions of the paper are presented in Chapter 5.0. Finally, acronyms and references are presented in Chapter 6.0 and 7.0, respectively.

The personal reflections reported in this paper are based on participation in several projects that were commissioned to FOI, the Swedish Defence Research Agency (DRA), by the Swedish AF. The Swedish AF has not, however, explicitly commissioned any research leading to the preparation of this paper. The opinions, conclusions, and recommendations expressed or implied within this paper are consequently solely those of the author. They do not necessarily represent the views of the Swedish Government, the Swedish Ministry of Defence (MoD), the Swedish AF, FOI, or any other Swedish Government agency. The paper has been cleared for public release and for unlimited distribution by FOI.

## 2.0 CONCEPT DEVELOPMENT AND EXPERIMENTATION IN THEORY

Once the project to produce a Swedish CD&E Handbook commenced, it was quickly established that nowhere had an identical project already been done. Similar projects were identified [9, 10], but none with the same level of ambition, i.e. to produce a document that could be used for education and as a theoretical guide for those managers, concept developers, experimenters, analysts, etc. that should use the CD&E method in practise. As far as the small working group could find out, there was no CD&E Handbook already in existence anywhere in the world. In fact, there were very few comprehensive descriptions of the CD&E method to be found at all [4, 9, 10]. As for the explicit components of CD&E method, i.e.

descriptions of military concepts, military concept development, and military experimentation, the situation was decidedly better, even if consensus regarding terminology and definitions was non-existent. From an analytical point of view, however, existing documentation left the analyst wanting regarding the more implicit components of the CD&E method. Descriptions of how analysis and analytical methods and tools should be used in conjunction with the CD&E-method were few in existence, and without detail.

During the first half of 2008, the author of this paper performed an extensive literature study, primarily in order to answer six questions: "What is a military concept?"; "What is military concept development?"; "What is military experimentation?"; "What is military concept development and experimentation?"; "What is validation of a military concept?"; and "What is analysis in military concept development and experimentation?". In this chapter, some of the identified answers to these questions are presented as a background to the ensuing discussion. When the literature study commenced, it was already appreciated that it would not be trivial, if at all possible, to identify a universally accepted definition regarding what CD&E was. It was not anticipated, however, that there should also be such a widespread lack of consensus regarding what a military concept, military concept development, and military experimentation is.

There are many definitions of what a concept is in the military context. According to NATO AAP-6 a concept is defined as "*A notion or statement of an idea, expressing how something might be done or accomplished, that may lead to an accepted procedure*" [6]. The Canadian Forces Experimentation Centre (CFEC) defines a concept as "*The identification of a problem area or concern together with a hypothesis to remedy the situation or solve the problem. It may also be revolutionary, evolutionary and/or innovative forces that drive the requirement for new technology, new structure, new business processes and partners*" [8]. Yet another contribution states that "*A military concept is the description of a method or scheme for employing specified military capabilities in the achievement of a stated objective or aim. This description may range from broad to narrow. It may range from describing the employment of military forces in the broadest terms and at the highest levels to specifying the employment of a particular technology system or the application of a particular training system*" [3].

In addition to the different definitions, there are several possible ways of categorising different types of concepts. The context is, of course, of paramount importance. In this paper only military concepts are considered. If the temporal aspect is of interest, concepts can be divided into historical, current, and future concepts [3]. There are four levels of military concepts, constituting a hierarchy: institutional concepts, which describe military institutions; operating concepts (strategic, operational, and tactical concepts), which describe how military forces operate; functional concepts, which describe the performance of individual military functions or sub-functions; and enabling concepts, which describe the capabilities required in order to perform military functions or sub-functions [3]. If the ground for classification is the purpose of the concept, concepts can be divided into capstone, enabling, and applied concepts [4]. Concepts can also be classified based on the maturity of the concept, whereby concepts can be defined as analytical, interim, and applied concepts [5]. There are, of course, other types of military concepts with which the concept in CD&E should not be confused. Three of these other types of concepts are Concept of Operations (CONOPS) [6], Concept of Employment (CONEMP) [5], and Concept of Use (CONUSE) [5].

The Technical Cooperation Program (TTCP) made a comparison [7] among its member nations (Australia, New Zealand, US, UK and Canada) regarding their utilisation of different concept terminologies and hierarchies. The TTCP also made an attempt at establishing the smallest common denominators. The result is illustrated in Table 1. Terms marked with an asterisk (*) in the table are not formally parts of that country's concept hierarchy, but represent attempts to identify corresponding activities in the hierarchical levels where these countries would otherwise have had gaps in the table.

As is demonstrated by Table 1, there is no consensus concerning concept terminology and concept hierarchy among the participating countries in the TTCP. In fact, there is not even any consensus regarding the number of levels in the hierarchy. The column to the far right in Table 1 represents the

TTCP attempt at finding the common denominator among terminologies and hierarchies. Further, it deserves to be mentioned that while the US and Canada advocate a hierarchical, top-down perspective, the UK propagate an approach based on processes, and Australia emphasises the importance of relationships.

<table>
<tr><th>UK</th><th>Australien</th><th>Kanada</th><th>USA</th><th>TTCP</th></tr>
<tr><td>Analytical Joint</td><td>Joint</td><td>Capstone</td><td>Capstone Concept for Joint Operations (CCJO)</td><td>Defence level</td></tr>
<tr><td>*Military Task Operating Concept</td><td>Australian Military Strategy</td><td></td><td>Joint Operating Concepts (JOC)</td><td>Mission</td></tr>
<tr><td>Analytical Environmental</td><td>Environmental</td><td>Environmental</td><td>*Service Concepts</td><td>Environmental</td></tr>
<tr><td>*Hybrid Concepts</td><td>Integrating</td><td>Integrating</td><td>*Joint Concepts</td><td>Integrating</td></tr>
<tr><td>Interim / Applied</td><td rowspan="3">Enabling<br>_____<br>*ConOps/ ConEmp</td><td rowspan="3">Functional<br>_____<br>*ConOps</td><td>Joint Functional Concepts</td><td rowspan="3">Functional and Enabling<br>_____<br>Capability Requirements and Acquisition</td></tr>
<tr><td>Interim / Applied Sub-concepts</td><td>Joint Integrating<br>_____<br>*Capability Development Document</td></tr>
<tr><td>ConEmp</td></tr>
<tr><td>ConUse</td><td></td><td>*ConOps</td><td>*Capability Production Document</td></tr>
</table>

**Table 1: Anglo-Saxon concept terminology and concept hierarchies [6].**

Definitions of what concept development is are not as abundant as are those of what a concept is. The Canadian Forces Experimentation Centre (CFEC) defines concept development as "*The process by which ideas are refined, accepted or rejected through the postulation of increasingly detailed hypothesis statements. This process permits the exploration of any concept to determine its merit and feasibility*" [8]. This definition eloquently and explicitly summarise those fundamental elements of concept development around which, perhaps, a consensus regarding the process of concept development does exist. Hence, concept development can be considered to be a process by which a concept matures by successive testing.

Concepts are not initiated in full form, nor are they fully realised after a few iterations. Concept development is not an orderly, sequential process, resulting in an engineered solution, where the final result is fully blueprinted at the beginning of the process. Instead, military concepts tend to form iteratively and incrementally over time, and military concept development is a process of exploration and experimentation and tends to unfold as a hypothesis-antithesis-synthesis dialogue [3]. Figure 1 illustrates the iterative nature of concept development, as well as the successive testing of the maturing concept.

Military experimentation is the main topic of several publications [9, 10, 11, 12, 13, 14, 15, 16, 17], the contents of which will not be repeated here. There are, however, several ways of categorising experiments, which deserves mentioning. Depending on the purpose; which can be to explore the effectiveness of something that has yet to be tested, to investigate the validity of a hypothesis, or to demonstrate a known truth, of the experiment; it can be classified as discovery, hypothesis-testing, or demonstration. Depending on the scope of the experiment, i.e. if the entire concept, parts of the concept, or only one part of the concept, is being tested, the experiment can be classified as Main Event (ME), Minor Integrating Event (MIE), and Limited Objective Experiment, (LOE), respectively. Most experiment employs some form of

simulation. Generally speaking, simulations can be divided into different categories based on a number of different criteria. Examples of such criteria include the handling of time (static or dynamic simulation), of probability (deterministic or stochastic simulation), and of variables (continuous or discrete simulation); as well as of how the simulation is finished (terminating or non-terminating simulation). In the military domain, simulations are traditionally categorised as constructive simulation, analytic war games, virtual simulation, and live simulation (field experiments).

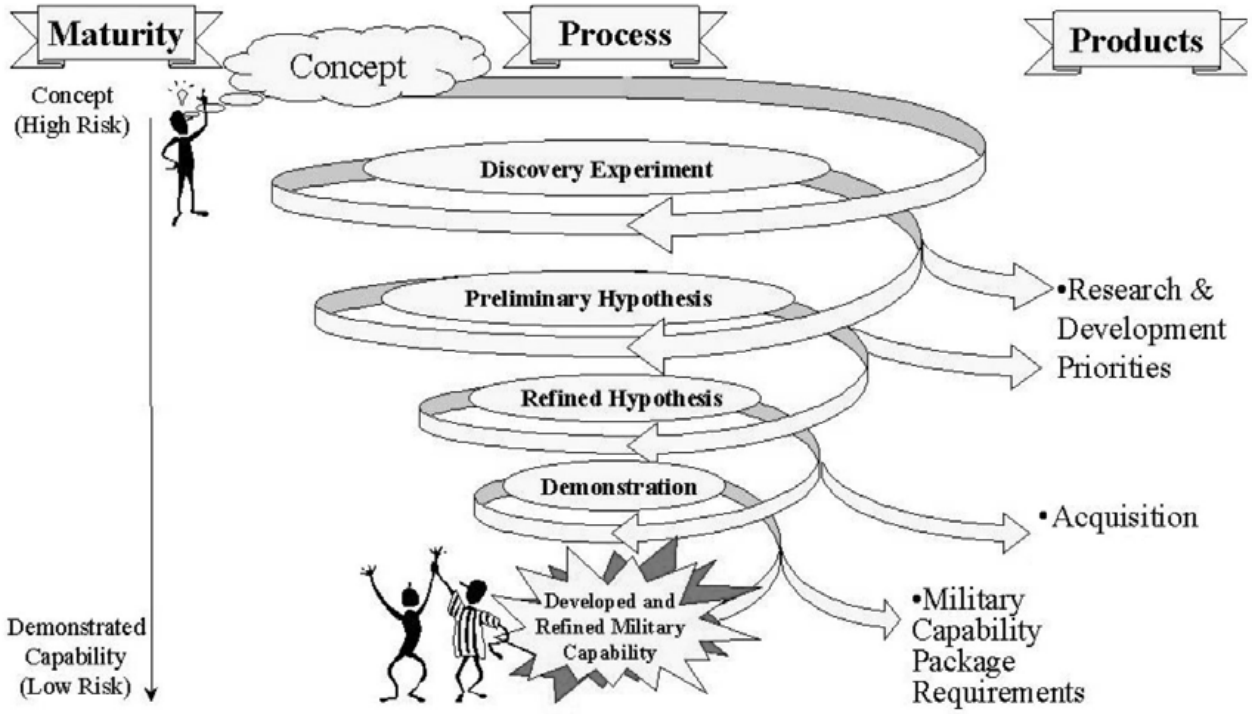


**Figure 1: A generic CD&E process [11].**

The combination of concept development and experimentation, i.e. CD&E, is described by NATO Allied Command Transformation (ACT) as a "*Companion process to the Capability Development Process (CDP) … provides important means to identify **possible solutions** to capability gaps … CD&E is **a** driving tool for NATO's transformation … enables structured development of creative and innovative ideas … provides mechanisms to turn these ideas into viable solutions … provides a pathway for new idea development … provides focus for future capability development … promotes collaboration amongst the Allies*" [4]. The Bundesamt für Wehrtechnik und Beschaffnung contributes with the following definition of CD&E: "*designates a method which allows us to predict, by way of experimentation, whether certain concepts, theoretical constructs, sub-systems or systems are apt to meet the requirements imposed by the transformation process and can be constructively integrated into an overarching system*" [18].

An essential part of CD&E is validation of the developing concept. The interdependence between concept development and the maturing concept has been beautifully described as "*A successful concept must undergo a validation process by which it is tested and eventually accepted or rejected by the institution. Any important military concept under consideration should be the subject of an open and honest debate within the institution. The validation process provides a sort of crucible through which the concept must pass – strengthening the concept in the process if it survives. In this way validation and development are closely linked. Like development, validation often tends to be disorderly. It occurs both formally and informally. Both are necessary in validating a concept. A concept may have been officially approved, but is not truly validated until it has been accepted by the stakeholders of the institution. Formal validation*

*takes place through workshops, war games, experiments or other activities held by proper authority for the express purpose of evaluating the concept. Informal validation occurs in the operating forces, professional schools and the institution at large in the form of field and map exercises and articles in professional journals. All are important in validating the concept. Acceptance takes some unavoidable period to grow. Some elements of a concept may gain acceptance more quickly than others. Some elements may gain acceptance while others are rejected. Just as it is in the development process, strong leadership is essential during the validation process. As a concept gains acceptance over time it transforms from a tentative hypothesis to a more-or-less accepted conclusion. Reflecting this, the language of the concept document may become increasingly assertive over the various iterations. By the time a concept is formally validated, the institution should be comfortable with it or should at least have had adequate time to weigh in on the subject*" [3].

It is obvious that a maturing concept must go through an iterative process during which is tested and validated before in continues its development. What is less obvious are the details regarding how this validation should be done, particularly in the early iterations of the process. When the concept approaches full maturity, full scale experiments are clearly appropriate, but what analytical tools that should be used early on in the process are less self-evident. The contents of such a process is sketchily outlined in several publications, e.g. "*The initial exploration of ideas in military concept development may typically involve workshops, conferences and articles in professional journals, and is typically followed by seminars and manual war games and only later by larger-scale exercises and simulations*" [3]; "*The potential Integrated Analysis and Experimentation (IAE) activities to support Concept Development can be broadly grouped: anticipating likely scientific and technological advances (and their implementation); historical analysis and historical research; workshops and problem solving techniques (including brainstorming); seminars; scenario-based workshops; modelling (including simulation); and experimentation (including Warfighting Experimentation (WFE)). The applicability of activities will vary at the various stages of conceptual development (analytical, interim, applied). Activities with a broader analysis base will have more utility earlier in the process, whereas those with greater depth will be more useful in later stages*" [5]; and "*In all likelihood, seminars, workshops, historical analysis, and the like, will also be required as part of the campaign to support and help inform the experimenters who will ultimately address the overall question. The campaign plan process must take these other activities into account within its design phase. The ultimate aim is to synthesise the outputs from all activities into coherent advice to the decision makers*" [10]. While analytical components are explicitly mentioned, there are no details of the analytical methodology, i.e. the "what's, when's, where's, how's, who's, and why's" are not explicitly explained. Evidently, it is presupposed that an external, objective organisation with the necessary competencies should assist the concept developers with planning, execution, and evaluation of the analytical support.

## 3.0 CONCEPT DEVELOPMENT AND EXPERIMENTATION IN PRACTISE

From the point of view of CD&E practise in Sweden, at least five different perspectives, related to five archetypal stakeholders, can be identified when discussing CD&E, i.e. the perspectives of: the concept developer; the experimenter; the manager; the analyst; and the scientist. In this chapter, the first four of these perspectives are noticeably and intentionally exaggerated, whereas the remaining one, the scientific perspective, is intentionally fragmented and claimed to be ambiguous and multiple, in order to demonstrate two irrefutable points. The first point being that depending on the perspective, the expectations on and requirements of CD&E differ quite significantly. The second point is that there is not one, but several, scientific perspectives, of which that of the natural scientist is not necessarily the most appropriate for CD&E. The CD&E method must, within reason, strive to satisfy the different stakeholders with their different perspectives, once the scientific perspective has been agreed upon within the community. The author of this paper is not so presumptuous as to pretend to have first hand experience from all perspectives, but asserts to have enough experience in order to outline these deliberately exaggerated perspectives, to some extent inspired by empery, and to multiply the scientific perspective,

exclusively encouraged by theory. This assertion is based on 16 years of experience in Operational Research (OR), whereof six years working as a CD&E analyst, which included working in close cooperation with concept developers, experimenters, analysts and managers of the experimental platform, and four years of part time studies as a PhD candidate in parallel, which have presented abundant opportunities to contemplate the different aspects of the philosophy of science and research methodology.

## 3.1 The exaggerated perspective of the concept developer – Artistic freedom

The concept developer would like to identify a problem or an opportunity by himself. He would then like to decide for himself whether or not to develop a concept based on his findings. Should he decide to develop a concept to solve a problem or capitalise on an opportunity, he would like to have the resources he needed, when he needed them, and for as long as he needed them. He would also like to decide for himself if he should deliver anything at all, what to deliver, when to deliver it, where to deliver it, how to deliver it, and to whom to deliver it. The concept developer does not really want a CD&E method, a CD&E process or any other form of CD&E structure. He wants his artistic freedom to do what he wants to, when he wants to, where he wants to, how he wants to, and with whom he should do it.

The concept developer does not really see the point in testing the maturing concept throughout its development. The concept developer is not interested in providing the manager with information at regular intervals concerning the current status of the maturing concept. The concept developer does not want to explore different alternative solutions, regardless of what the analyst advocates. The concept developer is not interested in serving the experimenter with his required input several months in advance of any impending experiments that still loom in the far distant. How should he, he asks himself, months in advance to boot, know which questions that he may want a distant experiment to address?

## 3.2 The exaggerated perspective of the experimenter – Timely order

The experimenter knows one thing for certain; the Experiment, with a “capital E”, was scheduled in time more than one year ago, in order to make sure that the necessary resources could also be allocated and scheduled in due course. Hence, the necessary resources, i.e. the experimental platform itself, as well as the required personnel, etc. have been allocated and scheduled to participate in the Experiment for at least one year by now. The experiments itself is less than six months away. While the resources are in place, even if the experimenter has learned the hard way that some of his resources will not show up for the Experiment, he misses one very important input in order to perfect the definite plan for the Experiment; which questions does the concept developer want to have answered through the Experiment?

The experimenter does nor really care what questions the concept developer wants to have answered. The experimenter does not even care which answers the Experiment will provide the concept developer with. The only thing the experimenter cares about is getting the correct input at the correct point in time, so that he can produce the final plan for the experiment, and devote his attention to actually receiving the necessary resources on the correct day, so that the Experiment will, in fact, be able to answer any questions at all. The experimenter does not really care about a CD&E method, a CD&E process or any other form of CD&E structure. He recognises, however, that a method, process, or other form of structure may assist him in getting the necessary input in time. How should he, he asks himself, otherwise make sure that the concept developer actually provides him with the necessary input in time?

## 3.3 The exaggerated perspective of the manager – Military relevance

The manager of the experimental platform, who is also the superior officer of the concept developer and the experimenter, has a perspective that is at least twofold. First of all, he knows that his superior officer, i.e. the HQ, will at any given point in time come to him with the request to put another concept into his “concept development and experimentation factory”. Regardless of whether or not the requirement from

the HQ is a whim, based on some new three letter acronym, he knows that he must be able to answer questions regarding the status of the ongoing concept development projects, including predictions of the future success, as well as questions regarding consequences for the ongoing development, should the HQ decide to push a new concept into the factory. In order to give the HQ relevant answers at any given point in time, he knows that his factory, i.e. the experimental platform, must have a method, process or other form of structure, which, over time, can provide him with adequate information regarding the status of the ongoing concept development projects. The yearly Experiments will not be sufficient to provide him with the necessary information. He knows that the steering group in the HQ convenes regularly, perhaps on a monthly basis. Hence he knows that he needs information that is, preferably, updated at least once a month. Regardless of the unpredictable fads of the HQ, the manager also has an interest to ensure that his scarce resources are utilised efficiently. Hence, secondly, he knows that he must provide his subordinates with a CD&E method, a CD&E process or other form of CD&E structure, so that he can make sure that "concepts are being produced correctly", or, in other words, that the scarce resources at his disposal are being used to develop the concepts in a fashion that is the most effective.

The orders from the HQ are, of course, not sudden impulses. The HQ has the ultimate responsibility that, at any given point in time, the factory is producing that which is most relevant for the AF. In order to ensure this, the HQ must, of course, receive relevant information from its subordinate, i.e. the manager of the experimental platform, so that it is possible for the HQ to make informed decisions, i.e. to make sure that the "correct concepts are being developed", or, in other words, that the scarce resources are being used to develop the concepts that are most relevant to the requirements of the AF. In short, the HQ recognises the need for gates in the process, so that concepts can be allowed to enter and exit the factory, as well as be terminated prematurely, etc., in an orderly fashion.

### 3.4 The exaggerated perspective of the analyst – Analytical structure

The analyst does not really care which concepts that are being developed. Even if he has an interest, it is not his job to do so. The military relevance is a matter that he gladly leaves with his military colleagues. The analyst cares about analytical structure, i.e. that concepts are being developed in the correct fashion. The analyst is convinced that there has to be an established CD&E method, a CD&E process or another form of CD&E structure, in order to make sure that concepts are being developed in the correct fashion. The analyst gets apprehensive when he cannot detect even the slightest evidence to suggest that any alternatives are being investigated by the concept developers. The analyst tries to argue that it is impossible for concept development to be that linear. Issues dealt with by the JCD&EC ought to be complex enough, the analyst argues, that different alternatives must be pursued in order to develop the concept in a correct fashion. The analyst argues that a trial and error approach ought to be the natural approach in CD&E. The analyst argues that the CD&E method must be iterative, and include tools that can eliminate irrelevant development branches as soon as possible. The analyst argues that an iterative approach, where the concept developer uses more and more advanced means of testing the maturing concept should be utilised. The analyst argues that the advantages of such an approach are threefold: it tests the maturing concept; it provides the decision makers with relevant information at regular intervals; and, if implemented correctly, it also provides the concept developers with an opportunity to create support among colleagues outside the CD&E community through the dialogue that tests like seminars, workshops, and war-gaming can enable.

The analyst is adamant about the necessity of a CD&E method, a CD&E process or another form of CD&E structure. The analyst is convinced that only through such a structured approach can the concept be developed with the necessary quality assurance; the necessary information to decision makers be provided; transparency of process be guaranteed; and an audit trail be provided. To realise these aspects of analytical structure it is, of course, imperative that necessary documentation is produced throughout the concept development process. Hence, the CD&E method, CD&E process or other form of CD&E structure that is implemented must, the analyst emphasises, also dictate which documents that should be produced, what

the documents should encompass, when they should be produced, how they should be produced, by whom the should be produced, etc.

## 3.5 The ambiguous perspective of the scientist – What is scientific rigour?

Judging by the statements of some commentators within the CD&E community, it would seem that they champion the notion that there is only one scientific perspective, advocating only one scientific method, and defending only one idea regarding what scientific rigour is. In reality this is, of course, far from the truth. In reality, there exist an almost infinite number of different possible scientific perspectives, where the dominating positivist perspective of the natural sciences only constitutes one extreme of an entire, continuous spectrum of different perspectives in the social sciences. There is no consensus regarding the terminology of what constitutes the other extreme of the spectrum, but terms like anti-positivism, interpretivism and phenomenology are frequently used. Somewhere in the middle of the road it is often argued that realism, or scientific realism, has its justification. Pragmatism is a term used to encompass those scientists who argue that you can select research paradigm, and that the research question should decide which paradigm you should choose. Pragmatists are advocates of mixed methodology, or multi-methodology, i.e. a combination of both qualitative and quantitative research methods. Even within the positivist paradigm, where the scientific method approximately can be outlined as consisting of asking a question; doing background research; constructing a hypothesis; testing the hypothesis with an experiment; and reporting the results; consensus is lacking regarding the testing of the hypothesis. Verificationists (like Lakatos) will claim that hypothesised regularities can be verified by an adequate experimental research programme, while falsificationists (like Popper) will maintain that hypotheses can only be falsified by experiments and never be demonstrated to be "true".

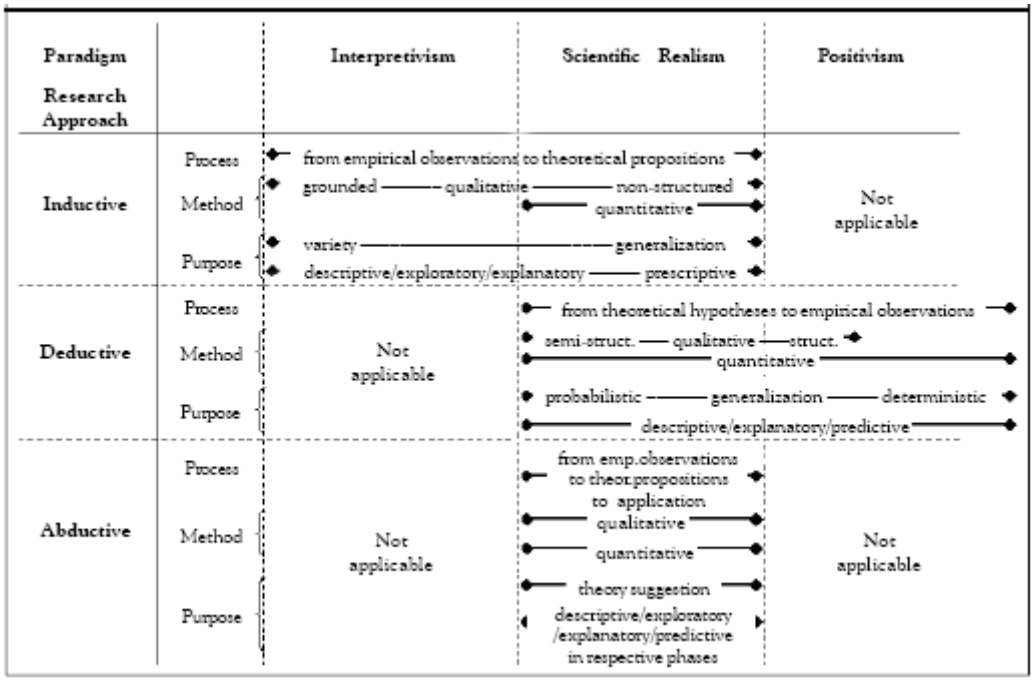


**Figure 2: Framework for theory building [20].**

A paradigm (as suggested by Kuhn) is a construct that specifies a general set of philosophical assumptions. These assumptions cover, e.g., ontology, epistemology, axiology, and methodology. One attempt [19], which substitutes axiology for view of human nature, at describing the extremes of the spectrum of possible paradigms for the social sciences, labels them the subjectivist and objectivist approach to social science respectively, where the latter approach corresponds to the positivistic paradigm

of the natural sciences. The objective approach is characterised as consisting of a realistic ontology, a positivistic epistemology, a deterministic view of human nature, and a nomothetic methodology. The subjective approach is characterised as consisting of a nominalistic ontology, an anti-positivistic epistemology, a voluntaristic view of human nature, and an ideographic methodology.

Given the brief account above, it should be obvious that there is more than one scientific perspective in existence. From the objectivistic (positivistic) point of view it would be argued that the social world exists independent of our appreciation of it; that what happens in the social world can be explained and predicted by searching for regularities and causal relationships between its constituent elements; that the traditional approaches which dominate the natural sciences are applicable in the social world; that man and his activities should be regarded as being completely determined by the situation or "environment" in which he is located; and that research should be based on systematic protocol and technique, i.e. scientific rigour (as defined by the positivists of the natural sciences).

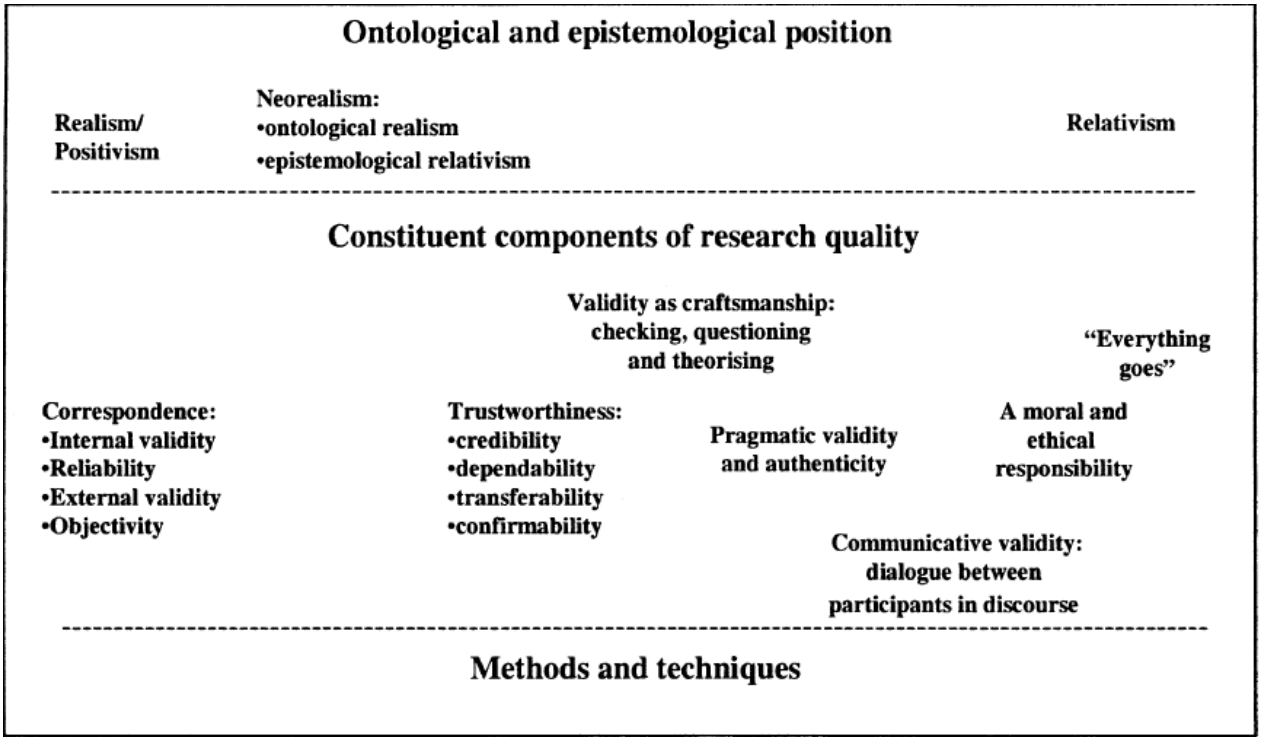


**Figure 3: Constituent components of research quality and their context [22].**

On the other extreme of the spectrum, i.e. from the subjectivistic (anti-positivistic) point of view, it would be argued that the social world does not exist independent of our appreciation of it; that the world is essentially relativistic and can only be understood from the point of view of the individuals who are directly involved in the activities which are to be studied; that man is completely autonomous and free-willed; and that one can only understand the social world by obtaining first-hand knowledge of the subject under investigation, i.e. by getting close to the subject and exploring its detailed background and history.

Between these two extremes, a wide variety of different positions, or paradigms, are possible. As indicated previously, scientific realism is one of these. Both extremes limit their respective freedom of action. Hence, from the perspective of theory building, the positivist is limited to using the deductive, or the hypothetic-deductive research approach, whereas the interpretivist is limited to using the inductive research approach. The scientific realist, however, reserves himself the privilege of selecting the inductive, deductive, or the abductive approach to research, as he deems appropriate in each individual case. Figure 1

illustrates the different freedoms of action for the interpretivist, the scientific realist, and the positivist.

The research approach at disposal is not the only aspect of the different paradigms that differentiate them from each other. One very poignant difference is the view on scientific rigour. From the positivistic point of view, scientific rigour has traditionally been discussed in terms of external validity, reliability, construct validity, and internal validity. Many positivists, who are predominantly quantitatively oriented in their approach to science, even go as far as considering their approach to scientific rigour to be the one and only, and maintain that it should be used also for qualitative research like case study research [21].

While the positivists still hold their ground, the last couple of years have seen an increased debate on the topic of scientific rigour. It has been argued that if there is a spectrum of possible paradigms, there ought to be a corresponding spectrum of possible approaches to scientific rigour and research quality. Figure 2 illustrates such a spectrum.

The point of view on scientific rigour is likely to depend on the scientific paradigm. The positivist of the natural sciences and the objectivist of the social sciences will argue that scientific rigour must be addressed with the classical instruments of external validity, reliability, construct validity, and internal validity. The extreme subjectivist of the social sciences will argue that “everything goes”. A more nuanced and pragmatic view is, perhaps, that trustworthiness should be considered as an alternative to the classical instruments when scientific rigour is discussed outside of the positivistic and objectivistic paradigms. The pragmatist will certainly argue that instruments for testing scientific rigour should be selected based on the context, i.e. based on the research question, the research approach, and the research methods.

To summarise, there are more scientific paradigms than positivism. Consequently, there are several alternatives regarding paradigm, scientific method, scientific rigour, and research approach.

## 4.0 DISCUSSION

When the research leading to this paper was conducted, there was no consensus regarding what a military concept is. Definitions, terminologies, taxonomies and hierarchies would seem to differ even among the English speaking countries, making the situation even more complex for countries with other languages, especially for small countries with an ambition to be interoperable with the international CD&E community. As long as e.g. enabling concepts and applied concepts have different meanings to different concept developers, international cooperation will remain unnecessarily complex. As is further accentuated by Table 1, there is no consensus regarding concept terminologies and concept hierarchies in the English speaking countries. Until definitions, terminologies, taxonomies and hierarchies are harmonised and standardised, international communication and cooperation in the area of CD&E will continue to be more complicated than it should have to be. Smaller countries will also have to decide with whom they should be interoperable. Bearing in mind that the issues at hand, i.e. the military problems and opportunities that are the inputs to the process, are already extremely complex in the first place, the added complexity outlined above seem superfluous.

Even if there is no consensus regarding definitions, terminologies, taxonomies, and hierarchies in the domain of military concepts, it seems to be quite straightforward what the most important elements of military concept development are, at least in principle. There are, however, a few problems in practice with the definition in Chapter 2.0. Should all concept development projects go all the way through to the major experiments? If so, based on what information should a manager of an experimental platform answer his superiors when they want to put a new development project into the “concept development factory”? If not, based on what information should development projects be terminated before reaching the major experiments? It seems obvious that CD&E must involve a process, enabling premature termination

of concepts, which provides relevant information to decision makers during the concept development.

There are also problems with the suggested definitions of what CD&E is. Is experimentation the only way of testing a developing concept's validity? Clearly, as is evident from the description of validation and IAE, experimentation is not the only form of testing. In addition to tests in the form of experiments, tests in the form of workshops, seminars, war gaming, Modelling and Simulation (M&S), etc, are suggested in the literature. Perhaps then, the name CD&E is misleading? Perhaps CD&IAE, for Concept Development & Integrated Analysis and Experimentation should be justified and even more appropriate? Or perhaps the interpretation of experimentation is too narrow? Perhaps experimentation should be interpreted so that it includes all the different forms of testing, from workshops to full-scale experiments? If so, however, most detailed descriptions concerning military experimentation would have to be fundamentally revised, since they are based on the "scientific method", i.e. the positivist experimental method of the natural sciences, which seems to be an inadequate and inappropriate method for the evaluation of workshops and seminars.

The lacking "A", for Analysis, in CD&E is problematic from the point of view of a smaller country with ambitions to use CD&E. Perhaps the answer lies in fact that hitherto, the CD&E method have primarily been described and outlined by large nations, like the US or the UK, or large, international organisations like the NATO ACT and the TTCP? Perhaps these countries and organisations see it as so obvious that analysis should be dealt with by an external organisation, so as bordering on being not only the self-evident practical solution, but also being the only theoretical solution? Judging by their descriptions of the CD&E method, it certainly does seem more than likely that they presuppose that planning, execution, and evaluation of IAE will be handled by an independent organisation. This is a luxury that smaller countries may, perhaps, not enjoy. Hence, from the point of view of a smaller country, where perhaps only one organisation, like a JCD&EC, will have to plan, execute, and evaluate all aspects of the testing of the maturing concept, including all elements of IEA, perhaps the CD&IAE method, including descriptions of all forms of testing the concept, would be a better name? Or perhaps CD&E is too complex for it to be applicable without the assistance of an external organisation for IAE?

Military concept development deals with highly complex problems and opportunities. Hence, concept development must be allowed to be a very creative and innovative process, i.e. with a considerable portion of "artistic freedom". Even though he does not really want a method, the concept developer must eventually realise that concept development for several reasons must follow some sort of structure. The CD&E method must, however, be able to provide enough analytical rigour, while, at the same time, it avoids suffocating creativity and innovation.

From the point of view of the experimenter, the Experiment, with a "capital E", is his part of CD&E. To satisfy the requirements of the experimenter, the CD&E method, or CD&E process, must describe when, how, in what form, etc., input is to be given from the concept developer to the experimenter. The CD&E method does not necessarily have to address this subject. A parallel description of the CD&E process or a Standing Operating Procedure (SOP) at the JCD&EC will suffice, but experience demonstrates beyond any reasonable doubt that this is an essential aspect of CD&E, and that it must be dealt with accordingly.

Regardless of source, the manager requires relevant information in order so ensure "military relevance", i.e. that at every given point in time "the correct concepts are being produced", and that "the concepts are being produced correctly". The manager definitely needs a formalised CD&E process, dictating who should produce which artefacts, and when, etc., so that he can give the HQ relevant information when it requires it. This process does not, however, have to be a part of the CD&E method per se.

The analyst has no preferences regarding the contents of the ongoing concept development. The analyst does, however, make a strong case for "analytical structure". Since military concept development is a complex issue, it seems justified that there should be a formal, iterative method that "forces" concept developers to study different alternative solutions and to test the maturing concept, with increasingly

intricate tests, as it develops. Quality assurance is an obvious and direct consequence of analytical structure. Another aspect of analytical structure is transparency of process. Since concept development does not results in the "right" or the "wrong" answer, it is imperative that is possible to follow the logic of how the answer has been produced. In combination with documented decisions regarding why specific concepts have been developed, while others have not, and documented decisions regarding premature termination, continuation, approvals, etc., the transparent development process will also contribute to the establishment of an audit trail.

The scientist perspective is not one, but an all but infinite number of possible perspectives. Hitherto, it is obvious that the positivist view of the natural sciences has been allowed to assume a predominant position. Whether or not this is intentional, based on meticulous deliberations, is difficult to establish built on existing literature in the field. The adoption of the positivist paradigm of the natural sciences means that the research approach must be deductive, or hypothetic-deductive, resulting in the "scientific method", the experimental method, or the empirical method. Within the positivistic paradigm scientific rigour is extremely rigidly discussed in terms of external validity, reliability, construct validity, and internal validity. The selection of the positivist paradigm excludes other paradigms like interpretivism, scientific realism, and pragmatism. Hence, research approaches like induction and abduction are also excluded, as is different views on scientific method and scientific rigour.

## 5.0 CONCLUSIONS

There is no consensus regarding concept definitions, terminologies, taxonomies and hierarchies within the CD&E community. Especially smaller countries, and countries with other first languages than English, would benefit tremendously from harmonisation and standardisation. Among other issues that might be resolved, interoperability would certainly be facilitated.

There is no question that CD&E is an iterative concept development process, during which a maturing concept's validity is being tested through increasingly more complex tests, and eventually terminated, detained, or approved. From a smaller country perspective, however, the question of validation activities, other than large scale experiments, constitutes a problem. Lacking the IAE resources of larger countries, enabling larger countries to rely on external organisations for the planning and execution of IAE, smaller countries must attempt different approaches to IAE. One solution is to describe IAE activities explicitly in the CD&E method, perhaps motivating a change of name to the CD&IAE method. Another solution is to accept that smaller countries can not utilise the CD&E method as it is described by larger countries.

There is no "A" in CD&E, neither for "Analysis" nor for "Anarchy". The CD&E method must certainly respect the requirement for a necessary degree of "Artistic Freedom" for the concept developers, but it definitely can not allow anarchy. Quite to the contrary, the CD&E method must instead provide enough "Analytical Structure" in order to assure concept quality and concept development quality, ensure transparency of process, and enable an audit trail. The CD&E method must also assist the production of relevant information to the decision makers, so that "Military Relevance" can be guaranteed, i.e. that at every given point in time "the correct concepts are being produced", and that "the concepts are being produced correctly". The issue of "Scientific Rigour" in CD&E would seem to require further deliberation within the CD&E community. It is far from clear whether or not the positivistic paradigm has been selected intentionally. Regardless of which, the CD&E community ought to deliberately consider, perhaps reconsider, which paradigm that should be used for CD&E. It is far from obvious that the positivistic paradigm of the natural sciences is the most appropriate paradigm for CD&E. Conversely, it seems likely that paradigms from the social sciences, such as interpretivism, scientific realism, or pragmatism, should be better suited to address CD&E. With such paradigms, the issues of scientific method and scientific rigour would come into an entirely new light.

## 6.0 ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ACT: | Allied Command Transformation |
| AF: | Armed Forces |
| C2: | Command and Control |
| C2-system M: | Swedish transformational development project for C2 system methodology |
| C2-system O: | Swedish transformational development project for C2 system organisation |
| C2-system P: | Swedish transformational development project for C2 system personnel |
| C2-system T: | Swedish transformational development project for C2 system technology |
| CA: | Comprehensive Approach |
| CD&E: | Concept Development and Experimentation |
| CD&IAE: | Concept Development & Integrated Analysis and Experimentation |
| CDP: | Capability Development Process |
| CFEC: | Canadian Forces Experimentation Centre |
| CONEMP | Concept of Employment: |
| CONOPS: | Concept of Operations |
| CONUSE: | Concept of Use |
| DBA: | Dominant Battle-space Awareness |
| DPA: | Defence Procurement Agency |
| DRA: | Defence Research Agency |
| EBAO: | Effects Based Approach to Operations |
| EBO: | Effects Based Operations |
| FMV: | The Swedish Defence Materiel Administration |
| FOI: | The Swedish Defence Research Agency |
| HQ: | Head Quarters |
| IAE: | Integrated Analysis and Experimentation |
| IAEC: | Integrated Analysis and Experimentation Campaign |
| IBM: | International Business Machines |
| ICT: | Information and Communication Technology |
| JCD&EC: | Joint Concept Development and Experimentation Centre |
| JFC: | Joint Forces Command |
| LL: | Lessons Learned |
| LOE: | Limited Objective Experiment |
| M&S: | Modelling and Simulation |
| ME: | Main Event |
| MIE: | Minor Integrating Event |

| | |
|---|---|
| M.O.: | Modus Operandi |
| MoD: | Ministry of Defence |
| NATO: | North Atlantic Treaty Organisation |
| NBD: | Network-Based Defence |
| NCW: | Network Centric Warfare |
| OR: | Operational Research |
| PE: | Precision Engagement |
| RMA: | Revolution in Military Affairs |
| RUP: | Rational Unified Process |
| SE: | Systems Engineering |
| SNDC: | Swedish National Defence College |
| SOP: | Standing Operating Procedure |
| SU: | Soviet Union |
| TTCP: | The Technical Cooperation Program (Australia, New Zealand, US, UK and Canada) |
| UK: | United Kingdom (of Great Britain and Northern Ireland) |
| US: | United States (of America) |
| WFE: | Warfighting Experimentation |
| WP: | Warsaw Pact |

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